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SCIENCE

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THE AEROLOGICAL CONGRESS AT MONACO

CONTENTS

| | |
|---|-----|
| <i>The Aero logical Conference at Monaco: PROFESSOR A. LAWRENCE ROTCH</i> | 193 |
| <i>The Darwin Centenary:—</i> | |
| <i>Address in Reply to the Reception of Delegates: DR. HENRY FAIRFIELD OSBORN</i> | 199 |
| <i>Peridermium Strobi Klebahn in America: DR. PERLEY SPAULDING</i> | 200 |
| <i>Scientific Notes and News</i> | 201 |
| <i>University and Educational News</i> | 204 |
| <i>Discussion and Correspondence:—</i> | |
| <i>American Men of Science and the Question of Heredity: DR. FREDERICK ADAMS WOODS, PROFESSOR J. MCKEEN CATTELL. Genera without Species: A. N. CAUDELL. A Note on Urophlyctis alfalfæ: ELIZABETH H. SMITH. The West Indian Seal at the Aquarium: DR. C. H. TOWNSEND</i> | 205 |
| <i>Scientific Books:—</i> | |
| <i>George Howard Darwin's Scientific Papers: PROFESSOR ERNEST W. BROWN. Minot on the Problem of Age, Growth and Death: PROFESSOR C. F. HODGE. Lillie's The Development of the Chick: PROFESSOR LEONARD W. WILLIAMS. Dellenbaugh's A Canyon Voyage: W. M. D.</i> | 212 |
| <i>Special Articles:—</i> | |
| <i>The Possible Ancestors of the Horses living under Domestication: PROFESSOR J. C. EWART</i> | 219 |
| <i>The Society of American Bacteriologists</i> | 223 |

THE international study of aerology, as the exploration of the atmosphere is now called, was begun by a small commission, including the writer as the American member, which was appointed at an International Meteorological Congress held at Paris in 1896. Although the commission bears the title "International Commission for Scientific Aeronautics," aeronautics serves only as the means of obtaining meteorological data in the free air. The work of the organization rapidly extended and five meetings were held in European cities before the session this year, which, by invitation of its honorary member, Albert I., Prince of Monaco, occurred during the first week of April in the new Oceanographic Museum at Monaco. The interest and importance of this, the sixth, reunion, served to bring together about thirty colleagues, from fourteen nations, the writer representing the United States Weather Bureau besides his own observatory at Blue Hill, where the first aerological observations in America were undertaken.

The meeting on April 1 was opened by Professor Hergesell, of Strassburg, president of the commission, who reviewed the progress made in exploring the air since the meeting at Milan three years ago, dwelling particularly on the extensive co-operation in the simultaneous series during six days in July, 1908, when balloons and kites were sent up from forty-four stations on land and sea in the northern and southern hemispheres. He emphasized the importance of determining the direction of the wind at different heights

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by observing pilot-balloons with theodolites.

The Prince of Monaco welcomed his guests to the new Oceanographic Museum, which he hoped would become a repository for the results of soundings of the air as well as of the sea, and to his yacht, *Princesse-Alice*, on which were made marine and atmospheric soundings from the equator to beyond the Arctic Circle. In speaking of the last the prince described the launch and recovery of a *ballon-sonde* at sea.

At the business meeting which followed, Professor Hildebrandsson was named vice-president of the conference. The death of Professor Pernter was announced and Professor Trabert, his successor as director of the Austrian Meteorological Office, was chosen a member of the commission. Other new members elected were: M. Vincent, head of the Belgian Meteorological Service; Dr. Kleinschmidt, in charge of the Lake Constance Kite-station; Captain Ryder, director of the Danish Meteorological Institute; Professor Bjerknes, of Christiania; Dr. Bamler, of Munich; the directors of the Russian observatories at Irkutsk, Tiflis and Ekaterinburg, and these military aeronauts: Captains Voyer and Bouttieaux, of France; Le Clément de St.-Marcq, of Belgium, and Colonel Capper, of Great Britain.

The program for the conference was intended to include: (1) technical questions relating to balloons and instruments; (2) methods, organization and equipment of expeditions; (3) reports of researches during the preceding year; (4) other questions, including new projects.

The International Commission on the System of World-stations, a subcommittee appointed by the International Meteorological Committee, also met in conjunction with the Aeronautical Commission.

In the first group, Dr. Assmann, director

of the Prussian Aeronautical Observatory at Lindenberg, described a new process of making *ballons-sondes* by dipping in a rubber solution instead of cementing sheets of rubber. The particles of dust in the latter cause the pores to open, but the dipped balloons expand five or six diameters without losing gas or bursting, permitting a greater height to be reached or a smaller balloon to be used. The parachute cords by friction on the rubber weaken it, or if two balloons are attached tandem, the smaller sets up oscillations injurious to the record; therefore Dr. Assmann proposes to put one balloon inside the other, one of them bursting on reaching the maximum altitude. He now employs a rubber captive-balloon of 14 to 17 cubic meters capacity, which loses no gas and therefore does not present pockets to the wind, and when carrying wire of 0.6 mm. diameter can reach an altitude of 4,000 meters. To avoid the chemical effect of insolation on the rubber the upper portion of the net is covered with a yellow fabric. A discussion followed as to the advantages of rubber and gold-beaters' skin for captive-balloons.

Dr. Assmann in another paper described an instrumental method to verify if, in the isothermal layer, the ventilation of thermometers is sufficient. While the upper inversion was shown as early as 1893 by the observations of Hermite and Besançon, yet for a long time it was attributed to insolation. This disturbance was later avoided by night ascensions and the descent of the balloon accelerated through letting gas escape by clockwork. The rubber balloon gives a very nearly constant velocity of ascent and this ventilation and a bright metal casing around the thermometer are generally thought sufficient. While it is doubtful whether extremely rare air can carry off heat from the thermometric strip, if there is no change when an artificial

current reinforces the downward draught, then the instrumental error may be assumed to be *nil*. Compressed air, contained in a globe of polished metal, is liberated against the thermometric strip during ten minutes by means of an aneroid barometer at the height when the inversion of temperature usually begins in cyclonic or anti-cyclonic conditions. This device has not yet been tried in the high atmosphere. The second part of Dr. Assmann's paper described an apparatus for ventilating thermometers in captive-balloons, especially during calm weather. A horizontal fan is driven by an electric battery, and a dipping-vane changes its direction of rotation when the descent begins.

In discussing the first subject, the president asked to have it noted that in spite of incredulity in some quarters regarding the reality of the upper temperature inversion, no member of this commission doubted its existence.

Professor Hergesell exhibited a new meteorograph for manned and captive-balloons having a bimetallic blade for temperature and a Vidi vacuum box for pressure, with an automatic ventilator for the former. This instrument made by Bosch, of Strassburg, weighs 1,200 grams and costs \$75. A discussion followed as to the use of a straight bimetallic blade instead of a curved one.

Professor Palazzo, of Rome, described two devices for launching *ballons-sondes* at sea, in which the Bourdon barometric tube liberates one of the tandem balloons or lets out the gas. In discussing the necessity of limiting the time of the ascensions other devices for the same purpose were mentioned.

Professor Rotch urged the adoption of a uniform method of publishing the kite data and suggested the form used at Blue Hill and Mount Weather. He pointed out the

confusion regarding the positive and negative sign attached to the temperature gradient in the official publication of the data derived from balloons and kites. Following the report of a committee appointed to consider the matter, the conference decided to express the gradient as positive when the temperature decreased with altitude and, in the published kite-observations, to give the simultaneous observations at the ground so far as possible.

Professor Köppen, of Hamburg, sent a memoir in which he proposed that, instead of the usual readings of the barometer, the data be expressed in absolute units of the C.G.S. system, and that the pressure be reduced to a height of 100 meters instead of to sea-level. This proposition was referred to the International Meteorological Committee.

Professor Bjerknes, of Christiania, read a paper on the theoretical application of upper air observations, in which he insisted that the object of aerological observations is to secure diagnoses about the momentary dynamic condition of the atmosphere. The series of ascensions should give data separated by such intervals as will permit the changes occurring between different diagnoses to be followed, so that by combining them it becomes possible to formulate laws by which the future state of the atmosphere may be predicted. He proposed to establish three diagnoses, namely, in the morning, at noon and in the evening, or at eight, one and seven o'clock, Greenwich time, but as the instrumental equipment will not permit all the diagnoses to be complete, that at noon is declared the principal one. At this moment kites and balloons with instruments are to be sent up and observations made at the ground which will enable the atmospheric conditions at different heights to be traced on charts. For the morning and evening diagnoses,

besides the ground observations, only pilot-balloons need be sent up, but sufficient in number to serve as a basis for charts of air movements.

Professor Bjerknes endorsed Professor Köppen's proposition to use dynamical units to express atmospheric pressure and wind-velocity, and in replying to questions as to the advantage of absolute measures he said that they avoided the introduction of constants in the application of dynamic equations and thus gave precision and simplicity. Tables facilitate the transformation of the old into the new units. Mr. Cave, of England, said that the upper-air observations in England were now published in the *Weekly Weather Report* in absolute units.

Mr. Cave read a request from his colleague, Mr. Dines, to have the *ballons-sondes* sent up about an hour before sunset to avoid insolation and yet allow them to be watched with a theodolite. Professor Rotch said that this practise had given good results in America, but the conference was unwilling to change the existing hour. It was later voted that beginning in July, complete observations be obtained as nearly as possible at 7 A.M., Greenwich time, as heretofore, but that pilot-balloons be sent up three times a day as desired by Professor Bjerknes during one of the monthly series of ascensions. There was also voted in this connection, a proposition of M. Vincent, to observe the state of the sky on the international days.

M. Teisserenc de Bort, of Paris, spoke on the result of his triangulation of *ballons-sondes* from 1898 to 1909 at Trappes and their importance for the verification of heights calculated by the barometer. The base-line used was 1,300 meters, but there is now a base of 5,000 meters. While the two methods agreed closely, the effect of hysteresis in the barometer was evident,

though the temperature-correction was small. M. Teisserenc de Bort exhibited charts of some trajectories of his balloons, which showed that the cyclonic rotation ceases at a certain height and is replaced by a calm zone that marks the top of the adiabatic temperature-gradient. Above this the currents are from the south and west and opposed to the surface-wind. In the tropics, superposed currents occur with a sudden change in direction at about 7,000 meters, the absence of cyclonic storms accounting for the stratification. As to the changes of wind in the "stratosphere," or region of the upper temperature-inversion, M. Teisserenc de Bort had found only slight changes, but Messrs. Cave and Hergesell agreed that the velocity of the wind decreased there. Professor Hildebrandson's observations of clouds confirmed those of M. Teisserenc de Bort with balloons, in showing a motion towards the north above 3,000 meters over a low-pressure area.

Continuing the technical questions, Professor Hergesell discussed the upward velocity of rubber balloons as a function of their lift and the use of pilot-balloons to determine the vertical currents of the atmosphere. In a closed space the velocity remains constant, so that, knowing the surface and free-lift of a balloon, its rate of ascent may be calculated, and there is little difference—about 4 per cent.—between the height obtained from angular observations of the balloon at one station, combined with its assumed velocity, and measurements of its height from the ends of a base-line. Successive observations of the displacement of the balloon enable the speed of the horizontal wind to be determined accurately. Often the vertical currents may be measured from angular observations at the corners of a triangular base, and a downward movement of 1.5 meters per second has been measured. In the discussion Captain

Hildebrandt, of Berlin, said that on the Peak of Teneriffe, pilot-balloons were driven down for three minutes at the rate of 2.5 meters per second and Gen. Kowanko, of St. Petersburg, mentioned the fact that when above a sea of clouds aeronauts found currents rising over the cloud summits and descending in the spaces between the clouds.

M. Teisserenc de Bort discussed the data relating to the upper isothermal stratum. Up to about 10 kilometers the decrease of temperature is almost adiabatic, then in the next 5 kilometers there is usually a rise in temperature of 8° to 10° C., with isothermal conditions up to at least 26 kilometers. The lower zone he calls the "troposphere," and the upper one the "stratosphere." The former is a region of violent atmospheric disturbances, for Hildebrandsen has shown that cyclones do not extend above the cirrus clouds, though anti-cyclones persist to greater heights, and therefore the stratosphere is lowest in the cyclone and highest in the anti-cyclone and its level sinks from the equator to the poles. The stratosphere is a region of interlaced currents and small vertical movements.

The following papers described the results of recent expeditions and investigations. General Rykatchef, director of the Central Physical Observatory, at St. Petersburg, exhibited charts of aerial soundings at various Russian stations. The higher level of the great temperature-inversion in anti-cyclones than in cyclones at St. Petersburg, and the isothermal condition prevailing in winter for several thousand meters above the ground at Asiatic stations, were some of the phenomena illustrated.

The most interesting report was presented by Professor Berson, assistant at Lindenberg Observatory, on his recent expedition to tropical East Africa and Lake

Victoria Nyanza. On the coast and from a specially chartered steamer on the lake, *ballons-sondes*, pilot-balloons and kites were sent up. The observations over the equator, in the center of the continent, showed very low temperatures at great heights, as did the expedition of Teisserenc de Bort and Rotch on the equatorial Atlantic, but with the difference that over the African continent there was a trace of the isothermal layer. The vertical changes were as follows: adiabatic decrease of temperature to 13,000 meters, between 13,000 and 15,000 meters a small inversion, and above 17,000 meters isothermal conditions. Above the southeast monsoon the wind was south-southwest and three times a westerly wind was observed between 15,000 and 18,000 meters, above the great equatorial current from the east which is supposed to prevail at all heights.

Professor Palazzo, director of the Italian Meteorological Office, described his aerological expedition to Zanzibar and to the east coast of Africa, in which *ballons-sondes* and pilot-balloons were launched from an Italian cruiser. Professor Hergesell gave some results of balloons sent up from a German cruiser in the neighborhood of the Canary Islands, and on the Peak of Teneriffe. He showed the effect of the distribution of barometric pressure on the trade-wind, which is especially influenced by the displacement of the center of maximum pressure over the North Atlantic. Professor Hergesell reaffirmed his belief that the effect of the Peak on the wind extends up to 6 kilometers above sea-level. Professor Rotch presented his volume giving an account and a discussion of the first observations with *ballons-sondes* in America, which were made at St. Louis from 1904 to 1907.

The communications relating to new projects included the promises of Dr. van

Bemmelen, of Batavia, to establish a kite station there, and of Mr. Davis, a director of the Argentine Meteorological Office, to do the same in this country. M. de Mas-sany gave an account of an aerological station about to be established at Keeskemét on the plains of Hungary, which plan received the approval of the commission.

Professor Hergesell spoke of the new observatory on the flank of the Peak of Teneriffe at a height of 2,400 meters, which he had just inaugurated in portable buildings furnished by the German emperor. Aerological stations in Spitzbergen and Teneriffe are of particular value and the desirability of the latter was expressed at the Milan Conference. Col. Vives y Vich, the Spanish military representative, took exception to some of Professor Hergesell's statements, and the following facts were agreed upon: The Aeronautical Commission was ready to establish an observatory on the peak with the aid of the Prussian government. The Spanish government objected, but recognizing the scientific value of the enterprise, it provisionally accepts the use of the temporary buildings offered by the Prussian government, through Professor Hergesell, until permanent buildings can be erected. Until such time the buildings will be considered Spanish property, and while the observatory will be open to savants of all countries, no preference can be given to Germans. The conference expressed its thanks to both the German and Spanish governments, and especially to the Spanish military aeronauts, for creating this observatory.

Professor Assmann read a suggestive paper on the application of aerological observations in aerial navigation. He cited the observations which were being made in the free air at various observatories and by expeditions on the oceans. Eventually it will be possible to construct synoptic charts

of the upper air which will enable predictions to be made of great value for aerial navigation. Even now, before a dirigible balloon ascends from Berlin, the observations in the free air from four stations are consulted. These views were approved by several members and Dr. Bamler thought it possible to obtain continuous registration in a captive-balloon maintained at a constant height. In this connection the attention of the aero clubs was called to the importance of making meteorological observations in all manned balloon ascensions and the assistance rendered in this respect by the Vienna Aero Club and the Austrian Minister of War was acknowledged.

It was voted to exchange copies of the traces of the automatic records between members on their request, and to send titles of new aerological publications to the *Fortschritte der Physik* in Germany and to the *Monthly Weather Review* in the United States. The next meeting of the Commission will be held at Vienna in the autumn of 1912.

Three sessions of the Commission on the System of World-stations were held with M. Teisserenc de Bort as president and Professor Hildebrandsson as secretary. The former made a report on his project for telegraphic meteorological stations and the latter explained his proposition to the International Committee in 1899 to establish meteorological stations around the great centers of action on the globe and showed the compensating types of weather occurring simultaneously in different regions. Thirty-eight stations, at important points around the globe between 70° N. latitude and 50° S. latitude, were selected, at which, besides the ordinary elements, the direction of the upper clouds, the temperature of the sea and the insolation at fixed altitudes of the sun are to be observed at the hour of the usual morning observation, except the

insolation, which is for the preceding day. For the study of the centers of action, the monthly means of observations are to be sent by the cooperating institutes to the president of the commission, but for the other system of stations the observations are to be telegraphed every day, or, if this is impossible, the weekly means can be telegraphed and, like the daily observations, published in the weather bulletins of the respective countries where they will be available for study.

Although the week was chiefly occupied with the scientific sessions, the prince entertained members of the commissions several times at the palace and on his yacht, the *Princesse-Alice*, where he himself participated in some oceanographical investigations. These, as well as the aerological work of the prince, were illustrated by an evening lecture given by his aide-de-camp, M. Bourée. The little time remaining was agreeably filled by a visit in automobiles to the Nice Observatory and by a performance at the opera of Monte Carlo. To the writer the prince expressed the desire that with the completion of the Oceanographic Museum, the principality of Monaco should be not only a pleasure resort, but also become a scientific center, and the Aerological Congress prove the precursor of meetings of a similar nature there.

A. LAWRENCE ROTCH

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THE DARWIN CENTENARY

ADDRESS IN REPLY TO THE RECEPTION OF
DELEGATES¹

CROSSING the Atlantic in honor of Darwin and rejoicing in the privilege of uniting in this celebration of his birth, we desire, first of

¹ By Henry Fairfield Osborn, LL.D., Hon.D.Sc. Camb., Da Costa Professor of Zoology, Columbia University, President of the American Museum of Natural History.

all, to render our tribute to the University of Cambridge.

To no other institution in any country may we turn with such a sense of filial gratitude. Through John Harvard, of Emmanuel, Cambridge became the mother of our colleges. Did not Emmanuel beget Harvard, and Harvard beget Yale, and Yale beget Princeton and other descendants to the third and fourth generation? We thus salute to-day the venerable but ever-youthful ancestor of many of the American universities, academies and institutes of science, national and state museums, represented here, and in large part guided by true sons of the true daughters of the alma mater on the Cam. Through the survival of the best, our political guidance is also passing more and more into the hands of men trained in these same daughter colleges. A son of Yale succeeds a son of Harvard as president of the United States. If your university men are leading the empire in times of stress, ours are leading the nation through the more perilous, because more insidious, times of prosperity. Thus in ever-widening growth is the influence of the Cambridge heritage. "Sir Walter," remarked Queen Elizabeth, "I hear that you have erected a Puritan foundation." "No, madam," he replied, "far be it from me to countenance anything contrary to your established laws; but I have set an acorn, which, when it becomes an oak, God alone knows what will be the fruit thereof."

The other offspring of Emmanuel, of Trinity, of Christ's and of the many pious foundations of the old university, are the great men, too numerous to name, but among whom there especially rise in our minds Newton, Clerk-Maxwell, Balfour, and above all, Darwin. Newton opened to us the new heavens, and Darwin the new earth. Clerk-Maxwell, with Herz, enabled us to converse with you through the blue ether.* The well-beloved Balfour revived the spirit of Von Baer; would that his life had been spared for the more difficult problems of our day. If in our hours of struggle with the mysteries of nature these are our leaders and companions, so in our hours of ease and relaxation do we not turn